IV. NOTES ON THE TADPOLES OF INDIAN ENGYSTOMATIDAE.

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The main object of this paper is to bring together all that is known about the larvae belonging to this family found in India and the Malay Peninsula, in order to facilitate further investigation being undertaken. Of the species reported to occur in India, Burma, and the Malay Peninsula, the life-history of only ten species has been worked out and it is the experience of herpetologists that to obtain the larvae of some of these and other forms is by no means easy, owing to the special modes of life adopted by the great majority of them. I am indebted to Dr. Annandale for the courtesy of allowing me to examine the tadpoles belonging to the species *Microhyla achatina*, ? *M. berdmorei* and *Kaloula pulchra* contained in the Indian Museum collection. The larvae of eight species have been described and annotated by different authors and only two[1] are described here for the first time.

The following is the bibliography on the subject :—

Annandale, N., *Mem. As. Soc. Beng.*, Vol. VI, pp. 150-153 (1917).

Butler, A. L., *Journ. Bombay Nat. Hist. Soc.*, Vol. XV, pp. 387-392 (1903-1904).

Ferguson, H. S., *Journ. Bombay Nat. Hist. Soc.*, Vol. XV, pp. 505-508 (1903-1904).

Flower, S. S., *Proc. Zool. Soc. London*, 1899, pp. 902-903.

Narayan Rao, C. R., *Rec. Ind. Mus.*, Vol. XI, p. 31 (1915).

Narayan Rao, C. R., *Rec. Ind. Mus.*, Vol. XIII, p. 281 (1917).

Smith, M., *Journ. Nat. Hist. Soc. Siam*, Vol. II, pp. 37 and 40 (1916).

Key for the identification of the larvae discussed below :—

Spiracle median, ventral ; mouth without beak or horny teeth	Engystomatidae.
A. Tip of tail ends in flagellum ; lower caudal lobe twice the dorsal at the base	*Microhyla.*
1. Head two-thirds of the body, former squarish. Body transparent, but not the sides . .	*M. ornata.*
2. Head less than half the body ; snout rounded, not squarish. Body not transparent . .	*M. rubra.*
3. Mouth surrounded by a float	*M. achatina.*
4. Body broader than long ; snout abbreviated and truncate	? *M. berdmorei.*
5. Body less regularly oval ; snout shorter ; tint green	*M. pulchra.*
B. Tip of tail not flagellate, but pointed ; caudal fin membranes of equal depth	*Kaloula.*
6. Spiracle a very large tube, nicked posteriorly. Body elongated, elliptical	*K. variegata.*

[1] They belong to the species *K. variegata* and *K. triangularis*. Dr. Annandale tells me that Dr. F. H. Gravely recently collected specimens of *K. variegata* at Chakradharpur in Chota Nagpur

7. Spiracle an inconspicuous transparent tube, not nicked. Body perfectly transparent, with a horseshoe-shaped mark on the head . . *K. triangularis.*
8. Spiracle almost forms a sheath for the root of the anal tube. Body densely pigmented . *K. pulchra.*
9. Spiracle not forming a sheath for the anal tube; length of body more than one and a half times the width . . . . . *K. obscura.*[1]

C. Tip of tail obtusely rounded. Tail lobes delicate and at greatest depth individually three-fourths of the muscular portion . . . . . *Cacopus.*

10. Spiracle a conical tube opening almost interfemorally. Body and muscular part of tail densely pigmented . . . . . *C. systoma.*

Microhyla rubra (Jerd).

Larva.

1904. Ferguson, *Journ. Bombay Nat. Hist. Soc.*, Vol. XV, p. 506.
1915. Narayan Rao, *Rec. Ind. Mus.*, Vol. XI, p. 31.
1917. Narayan Rao, *Rec. Ind. Mus.*, Vol. XIII, p. 282.

I have shown that Mr. Ferguson has mixed up these larvae with those of *M. ornata.*

Microhyla ornata. (Dum and Bibron).

Larva.

1899. Flower, *Proc. Zool. Soc. London*, p. 902.
1903-1904. Ferguson, *Journ. Bombay Nat. Hist. Soc.*, Vol. XV, p. 506.
1903-1904. Butler, *Journ. Bombay Nat. Hist. Soc.*, Vol. XV, p. 387.
1917. Narayan Rao, *Rec. Ind. Mus.*, Vol. XIII, p. 282.

Butler remarks "the tadpoles of this and other species of *Microhyla* are very peculiar, being almost perfectly transparent, with the viscera showing through conspicuously." The larvae of *M. ornata* have an opaque reflecting tissue on the sides and the only organ that shows through is the heart. Further down he observes "owing to their extraordinary delicacy I never managed to keep them alive." In my aquarium they thrive quite as well as any of the hardiest of the Ranid larvae.

Microhyla achatina (Boie).

Larva.

1916. Smith, *Journ. Nat. Hist. Soc. Siam*, Vol. II, p. 37.
1917. Annandale, *Mem. As. Soc. Bengal*, Vol. VI, p. 150.

The modification of the lower lip into a float-like structure resembling that met with in certain species of *Megalophrys* is an interesting fact.

? **Microhyla berdmorei,** Blyth.

Larva.

1899. Flower, *Proc. Zool. Soc. London*, p. 902.
1917. Annandale, *Mem. As. Soc. Bengal*, Vol. VI, p. 151.

Dr. N. Annandale[2] has shown that the 'transparent larvae' described by Flower are probably those of *M. berdmorei.*

[1] I have not had an opportunity to examine the larva and have had to rely on the description of Ferguson (*op. cit.*, p. 506).

[2] *Mem. As. Soc. Bengal*, VI, p. 151 (1917).

Microhyla pulchra (Hallow).

Larva.

1917. *Microhyla pulchra*, Smith, *Journ. Nat. Hist. Soc. Siam* II. p. 229.

Kaloula obscura, Günth.

Larva.

1903-04. Ferguson, *Journ. Bombay Nat. Hist. Soc.*, Vol. XV, p. 507.

Kaloula pulchra, Gray.

Larva.

1917. Annandale, *Mem. As. Soc. Bengal*, Vol. VI, p. 152.
1916. Smith, *Journ. Nat. Hist. Soc. Siam*, Vol. II, p. 40.
1903-04. Butler, *Journ. Bombay Nat. Hist. Soc.*, Vol. XV, p. 391.

Kaloula variegata (Stoliczka).

This is a very common frog in South India, whose presence after a heavy shower (not less than two inches) is detected by the peculiar cry represented by the syllables "Qhauy, Qhuay, Qhauy." It has been taken in the termites' nest in company with the black scorpion *Palamnaeus*.[1]

Larva.

Body oval, flat on both surfaces; length to breadth as 3 is to 2, snout rounded, truncate. Nostrils close to the median line, equidistant

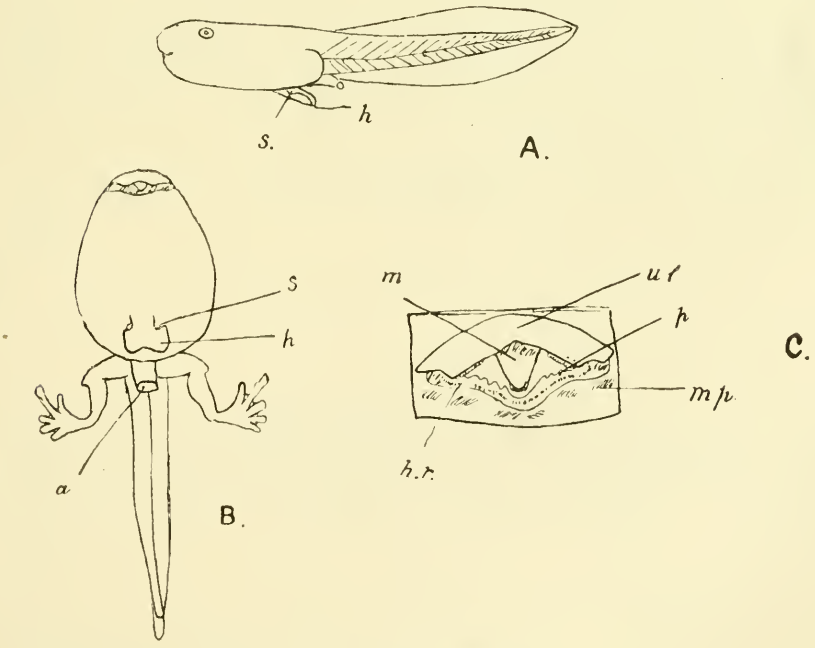

Fig. 1.—Larva of *Kaloula variegata*.

A. Side view. B. Ventral view. C. Mouth-parts.

a = vent; h = spiracular hood; h.r. = horny ridge; m = mouth; mp = muciferous pits; p = papillae; s = spiracular opening.

1 am indebted for this information to Dr. J. R. Henderson of the Madras Museum.

between snout and eyes. Internasal space about one-seventh the interorbital. Mouth terminal, both lips contractile and the lower occasionally with a horny rim and microscopic papillae which may extend to the corners of the mouth. A sensory groove connecting nostrils and eye.

Spiracle a large tube, notched behind ; anal tube median. Tip of tail pointed but not flagellate ; both lobes of equal depth, and arched. Greatest depth of tail about one-third the total length.

Body brownish, or gray with minute black spots ; occasionally a blue spot in the groin ; muscular part of tail blotched.

The following are the measurements of a fully grown tadpole :—

	mm.
Total length	45
Length of body	15
Length of tail	30
Maximum width of body	10
Maximum depth of body	8
Maximum depth of tail	10

In the aquarium these tadpoles were noticed to hide themselves under stones and avoid the lighted portion and in ponds they secrete themselves in the deeper recesses, darting to the surface periodically for the purpose of breathing. The metamorphosis is completed in 20 to 30 days in the aquarium, but in nature I have noticed it is over in a fortnight.

Kaloula triangularis (Günther.).

In South India this frog is more common in the hills[1], but is also frequently met with in the plains under a heap of dried leaves or other suitable cover in close proximity to pools of rain-water. Little is known about the habits of the adult.

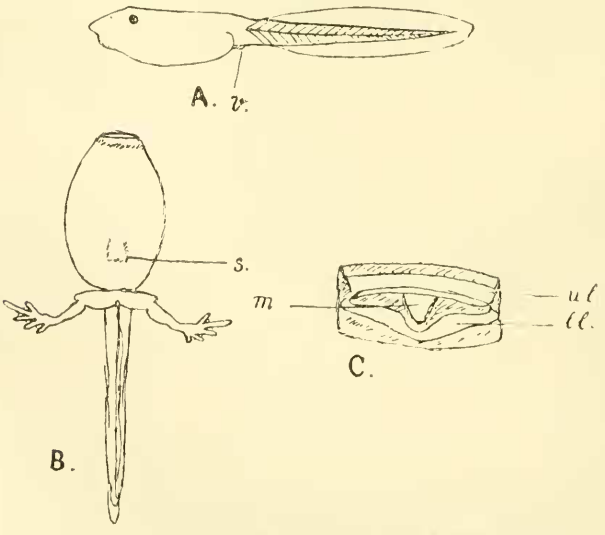

Fig. 2.—Larva of *Kaloula triangularis*.
A. Side view. B. Ventral view, C. Mouth-parts.

[1] Ferguson, *Journ. Bombay Nat. Hist. Soc.*, Vol. XV, p. 507.

Larva.

Body oval, flat ; breadth about three-quarters of the length. Snout acumiate, slightly truncated ; nostrils equidistant between the snout and eyes. Interorbital space about one-sixth the distance between eyes. Mouth small, without a horny rim or papillae. A naso-orbital sensory groove present.

Spiracle inconspicuous, the free hind edge not notched. Vent inconspicuous, median.

Tail very delicate, tip pointed. The muscular part deeper than the lobes.

Larvae perfectly transparent, with the viscera showing through. They become brown[1] when the front limbs sprout. A dark oval or horseshoe-shaped mark on the back which develops into a triangular blackish spot, occupying nearly the whole length of the back as metamorphosis progresses.

The following are the dimensions of a fully grown tadpole :—

	mm.
Total length	32
Length of body	13
Length of tail	19
Maximum breadth of body	9½
Maximum depth of body	6
Maximum depth of tail	7

The development is more rapid in this species than in *K. variegata* ; it was completed in the aquarium within two weeks ; the larvae when introduced measured about 22 mm. If it is assumed that the larvae take about a week to attain this size, then the whole metamorphosis occupies about three weeks.

Cacopus systoma, Schneider.

The adults, which are very common during the monsoon, are great burrowers. They emit a very characteristic sound by which their presence is easily detected. The cry[2] is not unlike the bleating of a goat.

Larva.

Ferguson, *Journ. Bombay Nat. Hist. Soc.*, Vol. XV, p. 507.

Addendum.

Dr. Malcolm A. Smith has just published an account of tadpoles from Siam in which he describes the larva of *Glyphoglossus molossus*, Günther, and shows that Flower's " transparent tadpoles " are those of *Microhyla butleri*, Boulenger. See *Journ. Nat. Hist. Soc. Siam* II, p. 261 ; 1917.

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[1] Butler makes a similar remark in connection with the larvae of *K. pulchra* (*Journ. Bombay Nat. Hist. Soc.*, Vol. XV, p. 392).

[2] I am informed by Dr. J. R. Henderson that in captivity, which they stand very well, they feed on termites in large numbers. This habit, coupled with their burrowing tendencies, must account for the small size of the mouth and the hind limbs armed with powerful metatarsal tubercles, a character shared by species like *Rana breviceps* belonging to a different family which have also similar habits.